Amendments to the Drawings:

The attached sheet of drawings contains changes to Figure 1a. This sheet, which contains Figure 1a, replaces the original sheet containing Figure 1a.

Attachment: Replacement Sheet
Annotated Sheet Showing Changes

REMARKS

With respect to claim 8, the Examiner has correctly noted that claim 8 has been retained in the application and its dependency corrected. The undersigned apologizes for not correctly indicating that this dependency had been amended in the response of July 7, 2004.

That amendment did indicate that the subject matter of claim 8 was being introduced into claim 1. Rather, what was intended, was to indicate that the subject matter of part of claim 8 was being introduced into claim 1. The remaining subject matter of claim 8 (the diagonal positioning of the inlets and outlets) has been retained in claim 8 and for this reason claim 8 has been retained. Again, this incorrect indication of the previous amendment was inadvertent.

The Examiner has objected to the disclosure to the disclosure, and requested a correction to page 13, line 2. In the amendments to the specification listed in the July 6, 2004 response, this correction was listed, as the last listed amendment. Accordingly, further correction does not appear necessary.

Drawings

As requested by the Examiner, an amended Figure 1a is attached, showing a proposed correction to the lead line for one of the reference numerals 250, to ensure that this reference is used consistently.

Claim Rejections - 35 U.S.C. 103

Before addressing the Examiner's detailed rejection of the claims, the present amendments to the claims are summarized and explained.

Firstly, in claim 1, a number of minor or editorial changes are being entered, solely to clarify the claim and without intending to substantively change the claim. Thus, the use of the designations a), b) to indicate different paragraphs are being deleted; the reference to solution is not consistently referred to as "hydride solution", in accordance with the antecedent at the beginning of the claim; the reactor plates are now consistently referred to as such.

Additionally, amendments are being entered with the intention of clearly distinguishing the claimed reactor vessel from the cited references. It is first noted that

the reference to "rectangular" present in the earlier amendment is now being deleted, since this feature is still present in claim 8 and since the Examiner has argued that this does not help distinguish from the prior art.

The most significant amendment is to replace the paragraph at the end of the claim, detailing the provision of gasket grooves, with two new paragraphs, providing greater detail on this aspect of the invention and also detailing the structure of the reaction chamber.

Thus, it is now provided that each solution flow field has a "common reaction chamber", and also a "plurality of channels". Further, it is provided that these channels open into the common reaction chamber and that the catalyst is provided in the reaction chamber.

Significantly, it is also now provided that there is a "rim" that is "provided around and partially defining the reaction chamber". As the Examiner noted in his comments on the drawings, reference 250 identifies a rim around each reaction chamber. Accordingly, no new matter has been added. With respect to the gasket grooves, these are now more clearly defined in a new, final paragraph of claim 1. Here, it is specified that the gasket grooves are provided between the reactor and separator plates, with one gasket groove being provided in the rim around each reaction chamber. Then, it is specified that gaskets are provided in the gasket grooves between adjacent pairs of reactor and separator plates.

It should be understood that the present invention is concerned with a reactor vessel for a hydride solution. As detailed in the Background of the Invention section of the present specification, the commonly employed reaction relies upon sodium borohydride that reacts with water to generate hydrogen and form sodium borate. Importantly, sodium borate has a low level of solubility. A common problem with such systems is that the reaction product, the sodium borate, can precipitate out of solution, clogging flow channels and the like.

The present invention provides a compact reactor configuration, which addresses the problem of ensuring that the solution can flow freely and that flow channels for the solution will not become blocked. This is achieved by providing for flow channels

opening into and facing a reaction chamber, for each reactor plate. The catalyst can then be provided in the reaction chamber, without obstructing or partially blocking the flow channels, as taught in the references. This is achieved by providing a rim around the area for the catalyst, defining the reaction chamber.

This rim serves a dual function. As noted, it partially defines a reaction chamber. Its second function is to provide a sealing surface in which a gasket groove is formed, for providing a seal between adjacent plates of the reactor vessel. This provides a compact and efficient construction for the reactor vessel.

Turning to the Examiner's rejection of the claim, the Examiner rejected claims 2, 3-5, 7 and 11-13 as being obvious under 35 U.S.C. 103(a) in view of Lippert et al. (WO 99/64146; US 6,470,569), in view of Ashmead et al. and further in view of Usher or Napper. For brevity and clarity, the remarks below address just the key points of the Examiner's argument while being fully responsive, and these remarks are without prejudice and applicants reserve the right to contest all aspects of the Examiner's analysis of the prior art.

The Examiner analyzed the Lippert et al. reference as disclosing a plurality of reactant channels (3) and a plurality of coolant flow field channels (6). It is noteworthy that, in this reference, the channels are all individual and do not open into any common chamber or the like. The Examiner further noted that the catalyst (4) is located on at least a portion of the plurality of reactant channels (3), as shown for example in Figure 3 of the reference. The indication in the drawing is that the catalyst would take up a substantial portion of the cross-section of each channel, effectively reducing the flow cross-section. In the context of potential use with a chemical hydride, this would increase the risk of blocking of the flow channels.

In any event, it is noted that, as was argued earlier that, Lippert et al. is concerned with a wholly different reaction scheme, mainly reformation of a hydrocarbon containing fuel. Such a reaction scheme does not have to address a problem of precipitation of a reaction product with potential blocking of flow channels.

The Examiner acknowledges (first full paragraph of page 5 of the Action) that the reactor vessel of Lippert et al. does not explicitly disclose means for joining the various

plates by clamping or the like. Indeed, Lippert et al. specifically teach away from any such alternative assembly technique. The clear teaching in Lippert et al. is that the various plates should be permanently jointed by soldering to provide a leak-tight structure.

The Examiner then relied upon Ashmead et al. for teaching the equivalency of clamping, welding and soldering. It is submitted that while Ashmead et al. may superficially appear of some relevance, this reference does in fact comprise non-analogous art. The introduction to this reference (col. 1, line 27-61) address deficiencies in conventional chemical processing techniques. There, it is detailed that, standard chemical industry practice, is to design equipment on a laboratory scale and then attempt to "scale up" to a commercial production scale. It is noted that there are numerous problems. In particular, inherently, as equipment is scaled up, the ratio of volume to surface area increases. In many chemical reaction schemes, this causes considerable problems and difficulties. For example, in large reactor vessels, it is hard to maintain homogeneity throughout the vessel and the chemicals in the interior of the vessel may experience quite different conditions from those adjacent the surface of the vessel.

Accordingly, the inherent teaching and thrust of this reference is, rather than to scale up from a laboratory scale process, one should consider scaling down to a much smaller scale, such as a "miniaturized chemical reactor" (col. 2, line 7). The entire reference is replete with references to components prepared on a small scale, e.g. references to "laminar" and "wafer". Under the heading "Method of Fabrication" in col. 14, it is detailed how techniques from the semiconductor processing could be used to produce the individual wafers etc. Clearly, the whole teaching is to produce equipment on a very small scale.

At the end of the detailed description, at col. 15, lines 26-36, it is detailed how the apparatus had spiral channels of 250 microns depth and the width of 3 millimeters and a length of 1900 millimeters, i.e. long and narrow. Such a configuration or scale would have absolutely no utility in the context of a chemical hydride system. Again, to repeat and to emphasize, when dealing with chemical hydride, there is always the potential for precipitate to be formed, so that one needs relatively large flow channels, which would

not be susceptible to blocking. A person skilled in the field of chemical hydride usage would not consider the Ashmead et al. proposal to be of any relevance.

Accordingly, given (1), the clear teaching by Lippert et al. away from the use of any other assembly technique other than soldering or its equivalent and (2) the application of Ashmead et al. to miniaturize chemical reactors of a wholly different scale, it is submitted that the Examiner has failed to establish a proper *prima facie* obvious argument under 35 U.S.C. 103.

The Examiner acknowledged that Lippert et al. and Ashmead et al. failed to disclose the provision of gasket grooves, etc. Accordingly, the Examiner relied upon Usher. The Usher reference is concerned with construction of heat exchangers. Accordingly, it is again submitted that this reference is of marginal relevance and constitutes non-analogous art. Accordingly, it is submitted that the Examiner has failed to make out a proper *prima facie* case of obviousness.

With respect to the Napper reference, this is not concerned with the fuel cell art. More particularly, neither Usher nor Napper are concerned with the arrangement as now claimed, where a reaction chamber, partially defined by a rim, and a gasket groove in the rim are provided. The rim thus provides a synergistic or dual function, that enables a compact assembly to be made. Accordingly, it is submitted that claim 1, as amended, is not obvious under 35 U.S.C. 103, in view of these references.

With respect to the Examiner's comments on limitations in claims 1, 3-5, 7 and 11-13 directed to a manner of operating the disclosed reactor vessel, the Examiner, in effect, noted that he could only give patentable weight to specific apparatus features. Nonetheless, it is submitted that the Examiner, in formulating rejections under 35 U.S.C. 103 must give weight to the intended use of the various apparatus under consideration. As argued above, apparatus intended for use with pure fluids, or chemical apparatus intended to function of a "micro" scale have no applicability to a reactor vessel intended for use in a chemical hydride solution, where precipitates can form.

With respect to the dependent claims, it is submitted that these claims are allowable both for introducing further patentable features and for being dependent from an allowable main claim. Again for brevity, relevant aspects of the Examiner's

arguments are addressed below, with applicants reserving the right to contest all such arguments.

The Examiner acknowledged that despite the combination of four references, namely Lippert et al., Ashmead et al., and Usher or Napper, such a combination failed to disclose the reactant inlet and the reactant outlet being located proximate to diagonal corners of the reactor plate, the coolant inlet and coolant outlet being similarly arranged, and the provision of the tortuous channels for the reactant and coolant flow field plates.

The Examiner relied upon Pellegri et al. or Godec et al. to argue that such aspects of the reactor plates are well known. In response, the Examiner is referred to applicants' earlier arguments. It is again noted that Pellegri et al. do not actually disclose any configuration of tortuous channels, while Godec et al. is, it is submitted, clearly concerned with non-analogous art.

Again with respect to claims 8, 28 and 30, it is submitted that references to the reactor being "configured to receive a hydride solution" may have little weight in determining the scope of the claim structure. However, such references are pertinent in considering whether a skilled person would consider or find it obvious to combine prior art references in any theoretical manner alleged by the Examiner.

With respect to claims 32 and 33, they are directed to a system for generating hydrogen including a solution supply means.

The Examiner relied upon Jung et al. and Amendola et al. for teaching that it is known to produce hydrogen by contacting a hydride solution with the catalyst. Clearly, this basic chemistry underlies the present invention. What is noteworthy in these two references is that they nowhere disclose a plate-like reactor structure as provided by the present invention. Indeed, both these references explicitly teach away from such a structure and both teach the provision of relatively large and open vessels. This again emphasizes the accepted teaching of this art that, due to the problem of precipitates, one should provide large open flow channels, to ensure that no clogging or the like can occur.

In contrast, the present invention provides a structure which provides a compact reactor vessel providing a relatively large surface to volume ratio, while addressing the

problem of potential clogging of flow channels. This is achieved by providing a reaction chamber that is relatively large on one side, so that the flow channels can have specific dimensions.

To provide this relatively large reaction chamber, each reactor plate is provided with the rim around the plate to define, at least in part, the reaction chamber, with the reaction flow channels opening into the chamber. The catalyst can then be provided in the reaction chamber, e.g. in the form of a solid foam or the like, so as to provide the large surface area necessary for the catalytic reaction, while not obstructing the flow channels.

To further provide for a compact and efficient structure, the rim, partially defining the reaction chamber, also provides for the sealing surface to seal adjacent plates together.

Such a configuration is nowhere taught in the prior art. Accordingly, it is submitted in the claims as amended are clearly both novel and unobvious over all the known art.

Respectfully submitted,

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Attachments

Annotated Sheets Showing Changes

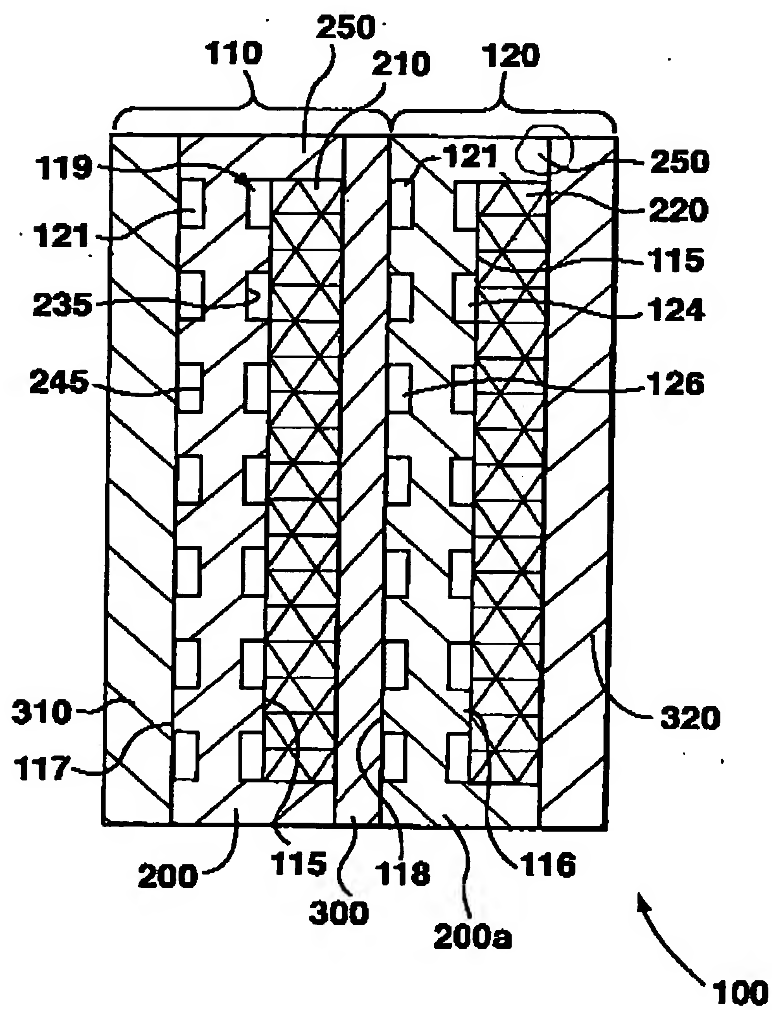

FIG. 1a

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